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Effect of Macroeconomic Variables on Stock Market Returns in India

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Abstract

The macroeconomic variables and stock market index are inter-linked. The objective of this paper is to investigate the cointegration between BSE Sensex and Macroeconomic variables.This study uses monthly data from April 2014 to June2019 to find the inter-relationship between BSE Sensex returns and selected macroeconomic variables by applying VECM technique. The five macroeconomic variables viz. index of industrial production, wholesale price-index, exchange rate, interest rate and foreign portfolio investment have been considered to represent the indicator of the economy in India. The BSE Sensex shows a positive relationship with index of industrial production while a negative relationshipwith the interest rate in the estimation. However, in some cases, probable direction of macroeconomic variable varies.

Keywords: *BSE Sensex, Macroeconomic Variables, Returns, APT, FPI, Cointegration and VECM.*

I. Introduction

The movement in stock indices is sensitive to the changes in macroeconomic behaviour of the economy.The effect of macroeconomic variables on stock market returns has been a long-debatedmatter amongst academicians and professionals. One way of linking macroeconomic variables and stock market returns is Arbitrage Pricing Theory (APT) considering multiple risk factors to explain stock returns. In aggregate stock market framework, a change in a given macroeconomic variable leads to a change in an underlying systematic risk factor that influences future returns.

Studies on the dynamic linkage between the macro economy and stock prices are few in India. In this article, the linking between macroeconomic variables and stock market returns has been investigated with reference to BSE Sensex. Understanding the effect of macroeconomic variables on the stock market indices with recent statisticsseems useful for investors as well as policy makers.A time series analysis can be used to examine the relationship between stock returns and macroeconomic variables. Cointegration and the Vector Error Correction Model (VECM) techniques have been appliedto investigate the relationship between stock prices and five

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macroeconomics variables such as industrial production index, wholesale price index, exchange rate,risk-free interest rate and foreign portfolio investmentin India.

Thisarticle is organized into the following sections. After the introductory section, section 2 emphasizesinsights from literature.Section 3rationalizes specification of variables. Section 4 discusses the data and methodology used in the analysis. Section 5 estimates the VECM model. The empirical results are reported and discussed in section 6 and conclusion of the study is provided in section 7.

II. Insights from Literature Review

Some empirical studies (Gehr (1975), Chen et al. (1986), Burmeister and Wall (1986), Brown and Otsuki (1990), Mukherjee and Naka (1995),Priestley (1996), Maysami and Koh (2000),Nasseh and Strauss (2000), Dhankar and Singh (2005), Humpe and Macmillan (2009), Dash and Rishika (2011), Pal and Mittal (2011) etc.) show that the there is asignificant relationship between macroeconomic variables and stock market returns.Chen et al. (1986) investigated the Arbitrage Pricing Theory model to estimate the U.S. stock returns considering selected macroeconomic variables and found that stock market returns are explained by macroeconomic variables. However, other studies (Poon and Taylor (1991), Pethe and Karnik (2000) etc.) show insignificant relationship between macroeconomic variables and stock market returns.

The literature indicates that the effect of macroeconomic variables on stock market returns is mixed. Itshows that stock prices do respond to the changes in macroeconomic variables differently and the sign and causal relationship may not hold same for all studies. The relationship of some macro variables could vary from market to market; may change in different sample periods and also in different frequency of data. Part of the differences in results is because of difference in methodology.

The study (Chen et al. (1986), Burmeister and McElory(1988), Hamao (1989), Poon and Taylor (1991)etc.) has used different methodsand found that asset returns are exposed to macroeconomic variables. Granger (1986), Johansen &Juselius (1990), Mukherjee and Naka (1995), Maysami and Koh (2000) etc.haveestablisheda long-term relationship between macroeconomic variables and stock market returns by using the cointegration method. A set of time-series variables are said to be cointegrated if they are integrated of the same order and a linear combination of them is stationary. Such linear combinations would then point to the existence of a long-term relationship among the variables (Johansen &Juselius, 1990).

Cointegration and Vector Error Correction Model techniques have been used to establishalong-run relationship between stock market returns and macroeconomic variables. Cointegration analyzes the dynamic co-movementamongvariablesandtheadjustment process towards long-run equilibrium.

III. Specification of the Variables

The fact that macroeconomic variables have a direct bearing on the share or security prices in India can be broadly enumerated. BSE Sensex is considered as the main indicator for the stock market in India.Thissectionrationalizesthe inter-relationship among stock prices and selected macroeconomic variables. Based on the available literature, index of industrial production, wholesale price index, exchange rate, interest rate, and capital flows have been used as the determinants of Indian stock prices. The directions of relationships of stock price changes with the variables have been discussed below.

Stock Market Index

I. BSE Sensex

BSE Sensex (Sensitive Index) is a basket of thirty constituent stocks which represents a sample of large, liquid, well-established and financially sound companies across key sectors. It is the oldest stock index in India. It was first compiled in 1986. The base year ofBSE Sensex is 1978-79. The BSE Sensex was initially calculated based on the full market capitalization methodology but hasnow shifted to the free-float methodology[2] with effect from September 1, 2003. As per BSE's Index Calculation, the formula for Index Value is given below. (BSE- Index Cell, 2019)

Index Value = (Free-Float Market Capitalization/Base Market Capitalization) * Base Index Value

Macroeconomic Variables

The choice of variables can be renationalized to examine a long-run relationship between macroeconomic variables and stock market prices in this section and indicate the direction in which the variables are expected to affect the stock prices. Selected macroeconomic variables are as listed below.

[2]*The free-float methodology does not include restricted stocks, such as those held by promoters, government and strategic investors.*

I.Index of Industrial Production

Index of Industrial Production (IIP) is used for the measurement of trend in the behaviour of industrial production over a period of time with reference to a chosen base year.An increase in the index of industrial production is an indication of a healthy economy and inducespositive sentiments among stock market investors.As a result, it increases expectations of better future performance and drives up the stock prices. Similarly, any slowdown in industrial production leads to slowdown in earning growth and it diminishesthe stock prices. On the above lines, the expected direction between industrial productionandthestock market index is positive, i.e., increase in industrial production leads to increase in stock market index.

II. Wholesale Price Index

Mathematically, inflation or inflation rate is calculated as the percentage rate of change of the Wholesale Price Index (WPI).The inflation rate for a year can be calculated by the formula given below.

$$\textbf{Inflation} = \frac{(\textbf{WPI of Current Year} - \textbf{WPI of Last Year}) \times 100}{\textbf{WPI of Last Year}}$$

Inflation is a significant national economy indicator as it determines how much of the real value of an investment is being lost, and the rate of return at which people need to compensate for that erosion. An increase in the rate of inflation is expected to lead to economic tightening policies, which increases the interest rates and hence reduces stock prices. However, in some casesthe expected sign between inflation and the stock market index may change.

III.Exchange Rate

The exchange rate is the value of one currency in relation to another. The price of a currency depends on supply and demand, which are affected by many factors, including interest rate differentials, relative inflation, export competitiveness, economy growth, deficits and debt. Exchange rate can influence demand for domestic or foreign-made products. A devalued rupee makes it more attractive to foreign customers to buy Indian goods, which boosts sales for Indian exporters, but it also makes it more expensive for Indians and Indian businesses to buy foreign products.This makes it an important factor in economy.The relationship between stock market prices and exchange rate can be in either direction dependingon the circumstances.Thus, the expected direction cannot be specified a priori.

IV.Treasury Bill Rate

Three-month treasury bills rate is used as a proxy for short-run risk-free interest rate. Generally,a 91 day-Treasury Bill rate is considered as the risk-free interest rate. An increase in interest rate will increase the opportunity cost of holding money and investors substitute holdings of fixed income interest bearing securities for shares which leads to fall in stock prices.Hence, stock market price may be inversely related to the Treasury Bill Rate.

V. Foreign Portfolio Investment (FPI)

Foreign Portfolio Investment (FPI) is a single, uniform route for foreign investment with substantial reduction in the procedures for trading in the Indian stock market by foreign individuals, firms and funds. As per the new norms of SEBI, following the recommendation of the Committee on Rationalisation of Investment Routes and Monitoring of Foreign Portfolio Investments', Foreign Institutional Investors (FIIs), FII Sub-accounts and Qualified Foreign Investors (QFIs) have been merged into Foreign Portfolio Investment (FPI) with uniform, relaxed procedures for foreign investment(SEBI Report, 2013, pp 4).Rao (1999) found that the FII investments positively influence the stock prices in India.Chakravarty&Mitra (2013) stated thata fall in FIIsreducesinvestmentandgrowth and that FIIs flows havedirect effect on stock prices in India.The stock market index is strongly linked to capital flows.On the above lines, the expected direction between FPI and stock market index is positive, i.e., increase in FPI leads to increase in stock market index.

IV. Data and Methodology

The techniques for the data analysis include the Unit Root Test, Cointegration and the Vector Error Correction Model to find the effect of macroeconomic variables on stock market returns with reference to BSE Sensex.This section is divided into two sub-sections, namely, Data Description and Methodology.

Data Description

Atime series dataat monthly frequency is usedfor the period fromApril2014 to June 2019which comprises 63 data points for the analysis. The data isobtained from the Handbook of Statistics on Indian Economy, Reserve Bank of India (RBI) and Bombay Stock Exchange Ltd. (BSE). The BSE Sensex is an indicatorofthe stock market in India. Since it is difficult to incorporate all aspects to explain the stock market behavior, the selected macroeconomic variables are used as the state of economy, viz.index of industrial production, wholesale price index,Exchange Rate, 91-day Govt. of India T-Bill rate and foreign portfolioinvestorsinvestment in India. For stock market purposes, BSE Sensex is considered as the representative of the Indian stock market index in India.

The base period for BSE Sensex is 1978-79 = 100 and the base period for the macroeconomic variables is 2011-12 = 100. IIP is used as a proxy for Gross Domestic Product (GDP), WPI is used to calculate inflation rate,

exchange rate (ER) used as benchmark for value of the currency, and three-month treasury bills (91 T-Bill) rate is used to incorporate the short run risk-free interest rate. Foreign portfolioinvestment (FPI) is used to interlink the foreign investment in India.

All variables (except T-Bill rate)are converted into natural logarithmic form for analysis purpose.Description of variables is depicted in the following **Table 1**.

Table 1: Description of the Variables

Abbreviations	Construction of Variables	Data Source
SENSEX	Natural logarithm of the monthly average ofBSE Sensex Index	BSE
IIP	Natural logarithm of the monthly Index of Industrial Production	RBI
WPI	Natural logarithm of the monthly Wholesale Price Index	RBI
ER	Natural logarithm of the monthly average exchange rate of the Indian Rupee	RBI
TBILL	Month-end rate of the 91-day Government of India treasury bills	RBI
FPI	Natural logarithm of the month endequity trade value of the foreign portfolio investorsinvestments	SEBI

Source: Author Formulated.

Methodology

The VECM method requires investigation ofstationary properties of the series.The most standard and widely used test for thisis the unit roottest.The unit root test is conducted to test whether data series in the model are stationary or non-stationary. In a multivariate context, if the variables under consideration are found to be integrated I(1) (i.e. they are non-stationary at level but stationary at first difference), but the linear combination of the integrated variables is I(0) (i.e. stationary), such variables are said to be cointegrated (Enders, 2004).

Unit Root Test

Stationarity of a variable can be checked by unit root test. If a time series is stationary, its mean, variance and auto covariance at various lags remain the same. Unit root stochastic process can be explained with the help of the first order autoregressive model.For estimating anauto-regressive model,itcan be assumed that,

……..(1)

Where:

Y_t is the value of Y at period time t.

Y_{t-1} is the value of Y at period time t-1.

e_t is the value of error term at time t.

Y_t has a unit root when $a_1 = 1$.

The presence of unit root specifies that the data series is non-stationary.Three standard procedures of unit root test, namely,Augmented Dickey Fuller(ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) testscan be conducted to check the stationarity of the series.The above test has been used to check the stationarity of the data series.

Cointegration

The concept of Cointegration was introduced by EngleandGranger(1987). Their formal analysis begins by considering a set of economic variables in long run equilibrium when

…… (2)

Whereβ and $x_t$denote the vectors (β_1, β_2, β_3…, β_n) and ($x_{1t,}$ x_{2t}, x_{3t}, …,x_{nt})'.

The Engel-Granger Cointegration method can only deal with one linear combination of variables that is stationary. In a multivariate practice, however, more than one stable linear combination may exist. Johansen permits

more than one cointegrating relationship. There are two types of Johansen tests, either with trace or with eigenvalue.Theλ_{trace} and λ_{max} test statistics can be used to help determine the number of cointegrating vectors. These tests are sensitive to the presence of deterministic repressors included in the cointegrating vector(s).

Vector Error Correction Model

The Vector Error Correction Model (VECM) is used to establish a long-run relation with short-run dynamics. A principle feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from long run equilibrium. If the system is to return to long run equilibrium, the movements of at least some of the variables must respond to the magnitude of the disequilibrium.

$x_{t.}$ $(x_{1t,}$ x_{2t}, x_{3t}, …,$x_{nt})'$ has an error correction representation, if, it can be expressed in the form

…… (3)

Where

π_0 = an (n . 1) vector of intercept terms with elements π_{i0}

π_i=(n . n) coefficient matrices with elements $\pi_{jk}(i)$

π= a matrix with elements π_{jk}such that one or more of the $\pi_{jk} \neq 0$

ε_t = an (n . 1) vector with elements ε_{it}

Note that the disturbance terms are such that ε_{it}may be correlated with $\varepsilon_{jt.}$and all variables in $x_t$areI(1). Now if there is an error-correction representation ofthese variables as in the above equation, there is necessarily a linear combinationof the I(1) variables that is stationary. Solving the above equation forπx_{t-1} yields

…… (4)

Since each expression on the right-hand side is stationary, πx_{t-1}must also be stationary.

V. Estimation of the Model

The Vector Error Correction Model has been estimated bythe following procedures:

Pre-test for Stationary

As a preliminary exercise, it is required to pretest all variables to assess their order of integration.Cointegration requires the variables to be integrated of the same order. ADF, PP and KPSS tests have been applied to check the stationarity properties of the data series and it is found that all variables are individually integrated of order 1, i.e., I(1). The results are presented below in **Table 2**.

Table 2: Unit Root Test for Stationarity

Variables	**ADF Test** (H_0 : Variable is non-stationary)	**PP Test** H_0 : Variable is non-stationary	**KPSS Test** H_0 : Variable is stationary	**Order of Integration**
	t-Statistic	**Adj. t- Statistic**	**LM- Statistic**	
SENSEX	-1.18	-1.17	0.89***	1
ΔSENSEX	-8.19***	-8.28***	0.07	0
IIP	-0.08	-3.25	0.97***	1
ΔIIP	-5.90***	-26.27***	0.03	0
WPI	-0.59	-0.41	0.62***	1
ΔWPI	-4.64***	-3.95***	0.27	0
ER	-2.09	-1.51	0.65***	1
ΔER	-6.27***	-6.30***	0.09	0
TBILL	-1.89	-1.91	0.78**	1
ΔTBILL	-7.16***	-7.12***	0.27	0
FPI	-2.54	-2.50	0.94***	1
ΔFPI	-7.06***	-7.05***	0.21	0

Source: Author Estimated.

*Δ represents first difference, *** implies significant at 1% level, ** implies significant at 5% level and * implies significant at 10% level*

Pre-test for Lag-length Criteria

In the Johansen cointegration methodology, it is important to correctly identify the lag structure to be used so that the residuals of the estimated model are not autocorrelated.For lag-length selection, vector autoregression (VAR) has been estimated by using the undifferenced data. The computed selection lag-length criteria for the purpose are reported in **Table 3**.It is observed that lag order1 is selected by the criteria (SBC) and the criteria(HQ) and lag order 2 is selected by three of the criteria (LR, FPE and AIC).Therefore, lag2has been used in the estimation method.

Table 3: VAR Lag Order Selection Criteria

Endogenous Variables: SENSEX IIP WPI EXCH TBILL FPI **Exogeneous Variable: C**						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SBC**	**HQ**
0	501.58	NA	2.70e-15	-16.51	-16.30	-16.43
1	870.00	650.87	4.18e-20	-27.60	-26.13*	-27.02*
2	**912.97**	**67.33***	**3.43e-20***	**-27.83***	**-25.11**	**-26.76**
3	940.78	37.99	4.95e-20	-27.55	-23.58	-26.00

Source: Authors Estimated.

** indicates lag order selected by the criterion*

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SBC: Schwarz information

criterion

HQ: Hannan-Quinn information criterion.

Testing for Cointegration (Johansen Methodology)

The model can be estimated in three forms: (i.) with all elements of matrix of intercept terms set equal to zero, (ii.) with a drift, or (iii) with a constant term in the cointegrating vector. Based on literature, cointegration with a constant term in the cointegrating vector has been tested. The properties of residuals of the estimated model have been analyzed and the residuals from the long-run equilibrium must follow a white-noise process. The value of the characteristic roots of the π Matrix has been estimated and the calculated values of λ_{max}(maximum eigenvalue) and λ_{trace}(trace statics)for the various possible values of r have been obtained.The results of both trace statics and the maximum eigenvalue test statistics are presented below in the **Table 4**. Trace statisticidentify more than one cointegrating vectors and maximum eigenvalue statistic identifies one cointegratingvector.After finding the cointegration relationship the normalized cointegrating vector(s) and speed of adjustment coefficients have been analyzed.

Table 4: Multivariate Johansen Cointegration Test Result

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	148.46	95.75	0.0000	52.11	40.07	0.0014
At most 1	96.35	69.81	0.0001	30.53	33.87	0.1189
At most 2	65.81	47.85	0.0005	25.18	27.58	0.0985
At most 3	40.63	29.79	0.0019	17.69	21.13	0.1418
At most 4	22.93	15.49	0.0031	14.73	14.26	0.0421
At most 5	8.20	3.84	0.0042	8.20	3.84	0.0042

Source: Author Estimated.

*Note: *denotes rejection of the hypothesis at the 0.05 level,*

***MacKinnon-Haug-Michelis (1999) p-values*

Vector Error Correction Model

Based on the Johansen Cointegrationmethodology,assuming one co-integrating vector, the Vector Error Correction Model has been estimated to check the variables who respond to the magnitude of the disequilibriumby applying the equations (3) and (4) as discussed in the Section 4.The results can be seen below from the **Table 5**, which show existence of a long-run equilibrium relationship between the stock market indices and the macroeconomic variables.

Table 5:Vector Error Correction Estimates

(Long-run Relationship)

Long-run	IIP	WPI	ER	TBR	FPI	Constant
BSE Sensex	**-1.19** (0.46) [-2.60]	**-4.92** (0.76) [-6.41]	**-1.78** (0.63) [-2.81]	**0.22** (0.05) [4.86]	**-1.12** (0.22) [-5.03]	**0.03**

Source: Author Estimated.

Standard errors in ( ) & t-statistics in [ ]

VI. Results andInterpretationof the VECM

The final vector of variables for the cointegration relationship between BSE Sensex and macroeconomic variables is defined as the following function:

$$SI_t = F(IIP_t, WPI_t, ER_t, TBILL_t, FPI_t) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where$SI_t$is Logarithmic value of BSE Sensex at time t.

On the basis of our analysis (VECM), the long-run relationship between stock returns and macroeconomic variables presented in the **Table 5**can be re-expressed in equation form as:

SENSEX^ =-0.03 + 1.19IIP +4.92WPI + 1.78ER

-0.22TBILL + 1.12FPI…… (6)

The VECM results reveal that stock returns arepositively related to the index of industrial production, inflation rate,exchange rate and foreign portfolio investmentwhilenegatively related to the interest rate in the long-run. These results are robust and significant. The positive relationship between Sensex and IIP indicates that an increase in index of industrial production boosts the corporate earning which enhances the present value of the firm and therefore the stock prices increase. It may also increase the national disposable income and therefore more retail investment could be possible in the stock market.The reasonable inflation may be positively related to stock prices. The negative relationship between Sensex and interest rate shows that investors may substitute holdings of fixed income interest bearing securities for shares which leads to fall in stock prices.

VII. Conclusions

The relationship between stock market returns and macroeconomic variables by using the monthly data from April 2014 to June 2019 have been analyzed by applying the econometric tools of Cointegration and the VECM methods.Acointegratedrelationshipbetween BSE Sensex and macroeconomic variables has been established by using Johansen's co-integration procedure. The selected five macroeconomic variables are turning out to be significant for establishing a long-run relationship.

From cointegration methodology, it is observed that in the long-run, stock prices are positively related to index of industrial production.It also shows the same result withinflation rate, exchange rate and foreign portfolio investment. while negatively related to interest rate.It is also found that stock price is negatively related to 91t-Bill rate.An increase in interest rate may increase the opportunity cost of holding money and therefore investorsmay choice holdings of fixed income instead of holding stock shares which lead to fall in stock prices.

The result of this study supports the expected direction of IIP and ER which is similar tothe findings of Ray and Vani (2003) for India. It is found that the direction of FPI is positive andhighly significantto explian stock market in the long-run, which is also different to the result of Ray &Vani (2003), i.e., negligible influence of FII on stock market. This implies that there isdifferent result from different methodologies as applied VECM method and Ray & Vani (2003) have used VAR and ANNmethods for monthly data from April 1994 to March 2003 for India.

However, IIP and exchange rate are found insignificant in the findings of Pethe &Karnik (2000) for mothly data from April 1992 to December 1997.The exchange rate has no causal relationship with stock prices in the findingof Bhattacharya and Mukherjee (2006) for monthly data from April 1990 to March 2001. The observed resultis consistent with the one obtained for exchange ratein the finding of Maysami and Koh(2000) for Singapore.Thus, results vary because of different methodologies and different study periods.

The Stock Returns may depend upon many factors such as market and scrip related, political, social, economic and perception related as well as on certain abnormal circumstances. All the above factors directly or indirectly, largely or to some extent, affect the stock returns. This research considers macroeconomic variables and its relationship with stock market returns in India.This is the substantial study in India that examines the effect of macroeconomic variables on stock market returns. Hence, this study concludes that macroeconomic factors continue to affect the Indian stock market returns.Policy makers and investors may consider the above established relationship for analyzing the stock market behaviour.

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